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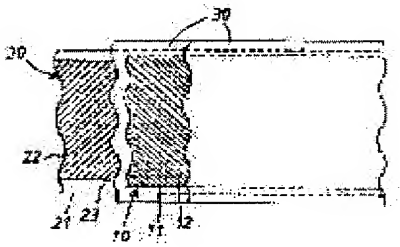
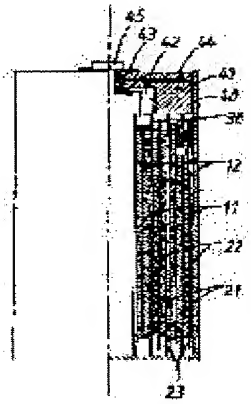
(54) LITHIUM ION BATTERY

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent short circuit by constituting an electrode body so as not to contact the negative electrode to a battery jar, when the battery jar to be a positive electrode is deformed by an external force.
SOLUTION: A plate width of a positive electrode plate 20 is formed wider than that of a negative electrode plate 10 and an applying width of the positive electrode active material on the positive electrode plate 20 is formed narrower than that of the negative electrode active material, and then a rolled-up positive electrode body A separated by a separator 30 from the negative electrode is formed by rolling up to be made the outer surface the positive electrode terminal. Accommodating the positive electrode body A with the electrolyte in a metal battery jar 40 to be the positive electrode terminal, the battery jar is sealed to make a lithium ion battery. Constitution this way, contacting of the battery jar 40 and the negative electrode 10 is prevented from occurring by a deformation of the battery jar 40, when dropping and so on and the occurrence of a short circuit is avoided.





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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The lithium ion battery which a positive-electrode board and a negative-electrode board are ****(ed) through separator, and it considers as an electrode object, is a lithium ion battery which contains this electrode object with the metallic-sheath can which serves as a positive-electrode terminal with the electrolytic solution, and comes to **** it, and is characterized by forming the board width of the aforementioned positive-electrode board more greatly than the board width of the aforementioned negative-electrode board while arranging the aforementioned positive-electrode board in the outermost periphery of the aforementioned electrode object.
[Claim 2] While applying a positive active material and the aforementioned positive-electrode board's becoming so that the both ends of a plate axis may be exposed, and the aforementioned negative-electrode board's coming to apply a negative-electrode active material all over a plate axis and making application width of face of the aforementioned positive active material smaller than the application width of face of the aforementioned negative-electrode active material The lithium ion battery according to claim 1 characterized by ****(ing) the aforementioned positive-electrode board and the aforementioned negative-electrode board through the aforementioned separator so that the whole surface of a portion where the aforementioned positive active material was applied may counter the aforementioned negative-electrode board.
[Claim 3] The aforementioned metallic-sheath can is a lithium ion battery according to claim 1 or 2 characterized by forming from aluminum or an aluminium alloy.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to a lithium ion battery, especially, it **** a positive-electrode board and a negative-electrode board through separator, uses them as an electrode object, and relates to the lithium ion battery which contained and ****(ed) this electrode object with the metallic-sheath can with the electrolytic solution.
[0002]
[Description of the Prior Art] In recent years, the miniaturization of electronic equipment and lightweight-izing are remarkable, and its request of the formation of small lightweight is very large also to the cell which serves as a power supply in connection with it. Although small lightweight cells, such as a lithium cell, were already put in practical use in the field of the primary cell, although these were primary cells therefore, they could not be used repeatedly, but the use was restricted. On the other hand, although the lead accumulator, the Ni-Cd battery, the nickel-hydrogen battery, etc. have been conventionally used in the field of a rechargeable battery, these have the big trouble in respect of the formation of small lightweight.
[0003] Then, a lithium ion battery comes to be put in practical use as a cell lightweight small in which charge and discharge are possible at high capacity, and it came to be used for a portable electron, communication equipment, etc., such as a small video camera, a cellular phone, and a notebook computer. Occlusion and the carbon system material from which it may be desorbed are used for this kind of lithium ion battery for a lithium ion as a negative-electrode active material. as a positive active material The lithium content transition-metals oxide of LiCoO2, LiNiO2, LiMn 2O4, and LiFeO2 grade is used. After assembling as a cell using the ion conductor which dissolved lithium salt in the organic solvent as a solute as the electrolytic solution, it is the cell by which the lithium ion which came out of the positive active material by first-time charge enters in a carbon particle, and the charge and discharge of it become possible.
[0004] This lithium ion battery applies a positive active material and a negative-electrode active material to a metal axis (foil), respectively, uses them as a positive-electrode board and a negative-electrode board, separator is put in in between, and winds it and uses it as an electrode object. After inserting this electrode object in a metal sheathing can, it is assembled by filling up with and ****(ing) the electrolytic solution in a sheathing can. As a metal sheathing can, sheathing cans, such as iron, a sheathing can made from stainless steel or aluminum, and a product made from an aluminium alloy, are used.
[0005] Here, when it constitutes so that a sheathing can may be used as a negative electrode and the outermost periphery of the above-mentioned electrode object may become a negative electrode, when using iron and the sheathing can made from stainless steel, and using aluminum and the sheathing can made from an aluminium alloy, it constitutes so that a sheathing can may be made into a positive electrode and the outermost periphery of the above-mentioned electrode object may become a positive electrode. Thus, while preventing the short circuit of a sheathing can and an electrode board by constituting, the metal of a sheathing can has prevented being eluted in the electrolytic solution.
[0006]

[Problem(s) to be Solved by the Invention] By the way, in a lithium ion battery, when the board width of a positive-electrode board is larger than the board width of a negative-electrode board, the lithium ion which comes out of the positive active material of the positive-electrode board which projected from the board width of a negative-electrode board on the occasion of charge concentrates on the both ends of a negative-electrode board, and a lithium dendrite comes to deposit. Therefore, in order to prevent the deposit of this lithium dendrite, while forming the board width of a positive-electrode board smaller than the board width of a negative-electrode board, it is ****(ing) so that the whole surface of a positive-electrode board may counter a negative-electrode board.
[0007] If external force joins a sheathing can by having fallen this lithium ion battery when what formed the board width of a positive-electrode board smaller than the board width of a negative-electrode board was used etc. and a depression etc. is produced at the bottom of a sheathing can here since a sheathing can serves as a positive electrode when using the sheathing can made from aluminum, or the sheathing can made from an aluminium alloy, the problem that the sheathing can and negative-electrode board used as a positive-electrode terminal contact and short-circuit will be produced. And a short circuit of a sheathing can and a negative-electrode board produces a possibility that the short circuit section may generate heat and a cell may be damaged.
[0008] Then, even if external force joins the sheathing can which is made in view of the above-mentioned trouble, and serves as a positive-electrode terminal and a sheathing can deforms this invention, it is in constituting an electrode object and preventing a short circuit so that this sheathing can and a negative-electrode board may not contact.
[0009]
[A The means for solving a technical problem, and its operation and effect] In order to be the lithium ion battery which this invention **** a positive-electrode board and a negative-electrode board through separator, and uses it as an electrode object, contains this electrode object with the metallic-sheath can which serves as a positive-electrode terminal with the electrolytic solution, and comes to **** it and to solve the above-mentioned technical problem In invention according to claim 1, while arranging a positive-electrode board in the outermost periphery of an electrode object, it is in having formed the board width of a positive-electrode board more greatly than the board width of a negative-electrode board.
[0010] Thus, while forming the board width of a positive-electrode board more greatly than the board width of a negative-electrode board Since this portion that deformed will contact the positive-electrode board formed more greatly than a negative-electrode board even if external force joins the sheathing can used as a positive-electrode terminal and a sheathing can deforms if a positive-electrode board is arranged in the outermost periphery of an electrode object It can prevent that the sheathing can used as a positive-electrode terminal and a negative-electrode board contact, and a short circuit can be prevented now.
[0011] In invention according to claim 2, apply a positive active material and an above-mentioned positive-electrode board becomes so that the both ends of a plate axis may be exposed. A negative-electrode board is to have ****(ed) the positive-electrode board and the negative-electrode board through separator so that the whole surface of a portion where the positive active material was applied might counter a negative-electrode board while it comes to apply a negative-electrode active material all over a plate axis and makes application width of face of a positive active material smaller than the application width of face of a negative-electrode active material. Thus, if application width of face of a positive active material is made smaller than the application width of face of a negative-electrode active material, even if it forms the board width of a positive-electrode board more greatly than the board width of a negative-electrode board, the deposit of a lithium dendrite can be prevented.
[0012] An above-mentioned metallic-sheath can is in invention according to claim 3 to have formed from aluminum or the aluminium alloy. Since specific gravity is smaller than iron or stainless steel, as for aluminum or an aluminium alloy, lightweight-ization of this kind of lithium ion battery is attained.
[0013]

[Embodiments of the Invention] Below, 1 operation form of the lithium ion battery of this invention is explained based on drawing 1 and drawing 2 . In addition, drawing 1 is drawing showing the state where positive and the negative-electrode board were piled up through separator, and drawing 2 is drawing showing the state where ****(ed) positive and the negative-electrode board piled up through separator, and it contained in the sheathing can.

[0014] a. Mix what dissolved the binder which consists of a negative-electrode active material which consists of a production natural graphite of a negative-electrode board, and a poly vinylidene fluorite (PVDF) in the organic solvent which consists of an N-methyl pyrrolidone, and consider as a slurry or a paste. The negative-electrode board 10 which these slurries or pastes were applied [in the case of the slurry] to homogeneity over the whole surface of both sides of the metal axis (for example, copper foil 40mm and whose thickness 320mm and width of face are 20 micrometers for length) 11 using the die coating machine, the doctor blade, etc. by the roller coating method etc. in the paste, and applied the active material layer 12 is formed.

[0015] Then, the inside of a dryer is passed for the negative-electrode board 10 which applied the active material layer 12, and a slurry or the organic solvent which was required for paste production is removed, and it is made to dry. Then, this dryness negative-electrode board 10 is rolled out with a roll-press machine, and it considers as the negative-electrode board 10 whose thickness is 0.14mm.

[0016] In addition, as a negative-electrode active material, occlusion and the carbon system material from which it may be desorbed, for example, graphite, carbon black, corks, a glassy carbon, carbon fibers, or these baking objects are suitable in a lithium ion in addition to a natural graphite. Moreover, you may use occlusion and the oxide from which it may be desorbed for lithium ions, such as a tin oxide and titanium oxide.

[0017] b. Mix what dissolved production one side of a positive-electrode board, the positive active material which consists of LiCoO2, carbon system electric conduction agents, such as acetylene black and graphite, the binder which consists of a poly vinylidene fluorite (PVDF) in the organic solvent which consists of an N-methyl pyrrolidone, and consider as a slurry or a paste. In addition, you may add additives, such as a polyethylene oxide, a polyacrylonitrile, and a cellulose, during a slurry or a paste.

[0018] In the case of a slurry, these slurries or pastes A die coating machine, A doctor blade etc. is used. in a paste, by the roller coating method etc. A metal axis (For example, aluminum foil 41mm and whose thickness 340mm and width of face are 20 micrometers for length) The positive-electrode board 20 which left the non-applied section 23 of about 1mm width of face to both-sides top of 21 and the soffit section, respectively, applied uniformly (a part is applied in addition only to one side), and applied the active material layer 22 is formed.

[0019] In addition, when it is made into the electrode object A mentioned later, this positive-electrode board 20 is applied to one side of the portion which becomes the outermost periphery so that an active material layer 22 may not be applied. Thus, while becoming possible to decrease contact resistance since the metal axis 21 and the sheathing can 40 come to contact directly if an active material layer 22 is not applied to one side of the positive-electrode board 20 of the portion which becomes the outermost periphery when it considers as the electrode object A, the useless active material which does not contribute to a cell reaction can be saved.

[0020] Then, the inside of a dryer is passed for the positive-electrode board 20 which applied the active material layer 22, and a slurry or the organic solvent which was required for paste production is removed, and it is made to dry. This dryness positive-electrode board 20 is rolled out with a roll-press machine after dryness, and it considers as the positive-electrode board 20 whose thickness is 0.17mm. Since, as for a cross direction top and the soffit section, the non-applied section 23 of 1mm width of face will be formed, respectively, the metal axis 21 will expose this non-applied section 23 for the positive-electrode board 20 by which such formation was carried out.

[0021] In addition, the lithium content transition-metals compound which can accept a lithium ion as a guest as a positive active material in addition to LiCoO2, For example, although LiNiO2, LiCoXNi(1-X) O2, LiCrO2, LiVO2 and LiMnO2, alphaLiFeO2, LiTiO2, LiScO2 and LiYO2, and LiMn2O4 grade are desirable It is suitable to use LiNiO2 and LiCoXNi(1-X) O2 independently, or

to mix and use these two or more sorts especially. Moreover, you may use conductive polymer, such as a polyacethylene and the poly aniline.

[0022] c. The negative-electrode board 10 and the positive-electrode board 20 which are the production **** of an electrode object, and were made and produced The fine porous membrane which reactivity with an organic solvent becomes from a cheap polyolefine system resin low, Carry out the fine porous membrane (for example, thing to which length turned up that 42mm and whose thickness 720mm and width of face are 0.025mm in the length direction at the half) 30 made from polyethylene in between suitably, and the center line of the cross direction of each plates 10 and 20 is made in agreement, and it piles up. Then, as the portion which it is made for the portion which the metal axis 21 of a portion with which the positive active material was applied only to above-mentioned one side making it the positive-electrode board 20 become outside (that is, it being made for the negative-electrode board 10 to become inside) exposed to become outside, and it exposed to it winds and it becomes the end section, it **** by the winder which is not illustrated. Then, after carrying out the tape stop of the outermost periphery and considering as a spiral electrode object, it fabricates in the form which can be inserted in a square shape sheathing can with a press machine, and considers as the electrode object A.

[0023] d. production of a lithium ion battery -- with the inner bottom of the square shape sheathing can 40 made from an aluminium alloy (a dimension is a thing with a height of 46mm, width of face of 22mm, a thickness [of 7.5mm], and a thickness of 0.5mm) fabricated by press working of sheet metal from the occasion and the single board After welding the positive-electrode lead which was welded to some positive-electrode boards 20 of the electrode object A produced as mentioned above and which is not illustrated, this electrode object A is inserted into the sheathing can 40. Then, a spacer 41 is inserted in the upper part of the electrode object A, and the negative-electrode lead 42 and the negative-electrode terminal 43 which were welded to some negative-electrode boards 10 are welded.

[0024] Then, the obturation board 44 is laid and obturated to opening of the sheathing can 40, and the electrolytic solution which added 1MLiPF6 as an electrolyte salt is poured into the mixed solvent which consists of the (ethylene carbonate EC) 30 weight section and the diethyl carbonate (DEC) 70 weight section. Subsequently, after welding the obturation cap 45 and the negative-electrode terminal 43 which serve as a negative-electrode terminal, it charges and considers as the lithium ion battery of this operation form. In addition, as the electrolytic solution, it is the ion conductor which dissolved lithium salt in the organic solvent as a solute, and ionic conductivity is high, it is electrochemically [chemically and] stable to each positive and negative electrode, and an usable temperature requirement is wide, and safety is high and uses a cheap thing.

[0025] For example, as an organic solvent, these mixed solvents, such as propylene carbonate (PC), a sulfolane (SL), a tetrahydro furan (THF), gamma-butyrolactone (GBL), dimethyl carbonate (DMC), ethyl methyl carbonate (EMC), 1, and 2 dimethoxyethane (DME), are suitable in addition to the mixed solvent of the above-mentioned ethylene carbonate (EC) and diethyl carbonate (DEC). Moreover, as a solute, the strong lithium salt of electronic suction nature is used, and LiBF4, LiClO4, LiAsF6, LiCF3SO3, Li(CF3SO2) 2N, and LiC4F9SO3 grade are suitable in addition to the above-mentioned LiPF6.

[0026] (Example of comparison) Below, the lithium ion battery of the example of comparison is explained based on drawing 3 and drawing 4 . In addition, drawing 3 is drawing showing the state where positive and the negative-electrode board were piled up through separator, and drawing 4 is drawing showing the state where ****(ed) positive and the negative-electrode board piled up through separator, and it contained in the sheathing can.

[0027] e. Mix what dissolved the binder which consists of a negative-electrode active material which consists of a production natural graphite of the negative-electrode board of the example of comparison, and a poly vinylidene fluorite (PVDF) in the organic solvent which consists of an N-methyl pyrrolidone, and consider as a slurry or a paste. The negative-electrode board 50 which these slurries or pastes were applied [in the case of the slurry] to homogeneity over the whole surface of both sides of the metal axis (for example, copper foil 40mm and whose thickness 320mm and width of face are 20 micrometers for length) 51 using the die coating

machine, the doctor blade, etc. by the roller coating method etc. in the paste, and applied the active material layer 52 is formed.
[0028] Then, the inside of a dryer is passed for the negative-electrode board 50 which applied the active material layer 52, and a slurry or the organic solvent which was required for paste production is removed, and it is made to dry. Then, this dryness negative-electrode board 50 is rolled out with a roll-press machine, and it considers as the negative-electrode board 50 of the example of comparison whose thickness is 0.14mm.
[0029] f. Mix what dissolved production one side of the positive-electrode board of the example of comparison, the positive active material which consists of LiCoO2, carbon system electric conduction agents, such as acetylene black and graphite, the binder which consists of a poly vinylidene fluorite (PVDF), the binder which consists of a poly vinylidene fluorite (PVDF) in the organic solvent which consists of an N-methyl pyrrolidone, and consider as a slurry or a paste. In addition, you may add additives, such as a polyethylene oxide, a polyacrylonitrile, and a cellulose, during a slurry or a paste.
[0030] The positive-electrode board 60 which these slurries or pastes were uniformly applied [in the case of the slurry] by the roller coating method etc. all over both sides of the metal axis (for example, aluminum foil 39mm and whose thickness 340mm and width of face are 20 micrometers for length) 61 using the die coating machine, the doctor blade, etc. in the paste, and applied the active material layer 62 is formed. In addition, when it is made into the electrode object B mentioned later, this positive-electrode board 60 is applied to one side of the portion which becomes the outermost periphery so that an active material layer 62 may not be applied.
[0031] Then, the inside of a dryer is passed for the positive-electrode board 60 which applied the active material layer 62, and a slurry or the organic solvent which was required for paste production is removed, and it is made to dry. This dryness positive-electrode board 60 is rolled out with a roll-press machine after dryness, and it considers as the positive-electrode board 60 of the example of comparison whose thickness is 0.17mm.
[0032] g. The negative-electrode board 50 and the positive-electrode board 60 of the example of comparison which are the production **** of the electrode object of the example of comparison, and were made and produced The fine porous membrane which reactivity with an organic solvent becomes from a cheap polyolefine system resin low, Carry out the fine porous membrane (for example, thing to which length turned up that 41mm and whose thickness 720mm and width of face are 0.025mm in the length direction at the half) 70 made from polyethylene in between suitably, and the center line of the cross direction of each plates 50 and 60 is made in agreement, and it piles up. Then, as the portion which it is made for the portion which the metal axis 61 of a portion with which the positive active material was applied only to above-mentioned one side while making it the positive-electrode board 60 become outside exposed to become outside, and it exposed to it winds and it becomes the end section, it **** by the winder which is not illustrated. Then, after carrying out the tape stop of the outermost periphery and considering as a spiral electrode object, it fabricates with a press machine in a square shape, and considers as the electrode object B.
[0033] h. production of the lithium ion battery of the example of comparison -- the product made from the aluminium alloy fabricated by press working of sheet metal from the occasion and the single board a square shape sheathing can (A dimension is a thing with a height of 46mm, width of face of 22mm, a thickness [of 7.5mm], and a thickness of 0.5mm) After welding the positive-electrode lead which was welded to the inner bottom of 80, and some positive-electrode boards 60 of the electrode object B produced as mentioned above and which is not illustrated, this electrode object B is inserted into the sheathing can 80. Then, a spacer 81 is inserted in the upper part of the electrode object B, and the negative-electrode lead 82 and the negative-electrode terminal 83 which were welded to some negative-electrode boards 50 are welded.
[0034] Then, the obturation board 84 is laid and obturated to opening of the sheathing can 80, and the electrolytic solution which added 1MLiPF6 as an electrolyte salt is poured into the mixed solvent which consists of the (ethylene carbonate EC) 30 weight section and the diethyl carbonate (DEC) 70 weight section. Subsequently, after welding the obturation cap 85 and the

negative-electrode terminal 83 which serve as a negative-electrode terminal, it charges and considers as the lithium ion battery of the example of comparison.
[0035] a fall experiment -- 100 lithium ion batteries of this operation form produced as mentioned above and 100 lithium ion batteries of the example of comparison produced as mentioned above are prepared The fall experiment (UL) which drops these 100 lithium ion batteries in the direction random to above the floor level [made from concrete] from the height of 1.9m of above the floor level, respectively was conducted by a unit of 500 times, respectively. When this experimental result was shown, a result as shown in the following table 1 was brought.
[0036]
[Table 1]

	短絡した電池の個数
本発明の電池	0個
比較例の電池	5個

[0037] There was nothing that the short circuit generated with the lithium ion battery of this invention so that more clearly than the above-mentioned table 1. Thus, if the board width (for example, 41mm) of the positive-electrode board 20 is formed more greatly than the board width (for example, 40mm) of the negative-electrode board 10, even if external force will join the sheathing can 40 used as a positive-electrode terminal and the sheathing can 40 will deform the reason used as the outstanding property It is because it can prevent that the sheathing can 40 used as a positive-electrode terminal and the negative-electrode board 10 contact and a short circuit can be prevented, since this portion that deformed will contact the positive-electrode board 20 formed more greatly than the negative-electrode board 10.
[0038] Moreover, if application width of face of a positive active material is made smaller than the application width of face of a negative-electrode active material even if it forms more greatly than the board width (for example, 40mm) of the negative-electrode board 10 the board width (for example, 41mm) of the positive-electrode board 20, the deposit of a lithium dendrite can be prevented.
[0039] Furthermore, since specific gravity is smaller than iron or stainless steel, if, as for aluminum or an aluminium alloy, the quality of the material of a metal sheathing can is made into aluminum or an aluminium alloy, lightweight-ization of this kind of lithium ion battery will be attained.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the state where positive and the negative-electrode board of 1 operation gestalt of this invention were piled up through separator.
[Drawing 2] It is drawing showing the state where ****(ed) the back and the negative-electrode board piled up through the separator of 1 operation gestalt of this invention, and it contained in the sheathing can.
[Drawing 3] It is drawing showing the state where positive and the negative-electrode board of the example of comparison were piled up through separator.
[Drawing 4] It is drawing showing the state where ****(ed) the back and the negative-electrode board piled up through the separator of the example of comparison, and it contained in the sheathing can.
[Description of Notations]
10 [— A negative-electrode active material layer, 20 / — A positive-electrode board, 21 / — A metal axis, 22 / — A positive-active-material layer, 23 / — The non-applied section, 30 / — Separator, 40 / — A metallic-sheath can (positive-electrode terminal), 45 / — Obturation cap (negative-electrode terminal)] — A negative-electrode board, 11 — A metal axis, 12

[Translation done.]

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2/02		2/02	Ｆ
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審査請求　未請求　請求項の数３　ＯＬ　（全　６　頁）

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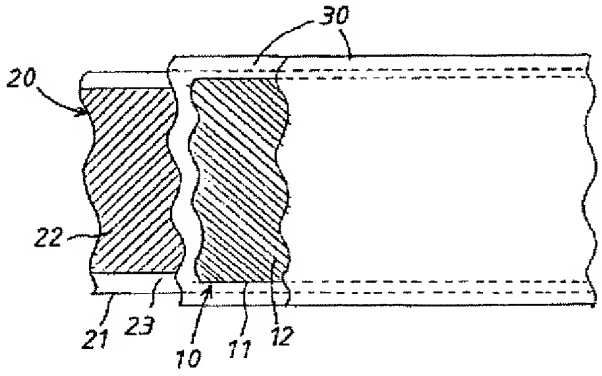
(54)【発明の名称】　リチウムイオン電池

(57)【要約】
【課題】　正極端子となる外装缶に外力が加わって外装缶が変形しても、この外装缶と負極板とが接触しないように電極体を構成して短絡を防止する。
【解決手段】　正極板２０の坂幅を負極板１０の坂幅より大きく形成するとともに、正極板２０への正極活物質の塗布幅を負極板１０への負極活物質の塗布幅より小さく形成し、かつ、セパレータ３０を介して巻回した電極体Ａの最外周が正極板２０となるように巻回する。この電極体Ａを電解液とともに正極端子となる金属外装缶４０内に収納した後、封缶してリチウムイオン電池とする。このように構成すると、落下等により外装缶４０が変形しても、外装缶４０と負極板１０が接触することが防止できて、短絡を防止することが可能になる。



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【特許請求の範囲】

【請求項１】　正極板と負極板をセパレータを介して巻回して電極体とし、この電極体を電解液とともに正極端子となる金属外装缶に収納して封缶してなるリチウムイオン電池であって、

前記電極体の最外周に前記正極板を配設するとともに、前記正極板の板幅を前記負極板の板幅より大きく形成したことを特徴とするリチウムイオン電池。

【請求項２】　前記正極板は極板芯体の両端部が露出するように正極活物質を塗布してなり、

前記負極板は極板芯体の全面に負極活物質を塗布してなり、

前記正極活物質の塗布幅は前記負極活物質の塗布幅より小さくするとともに、

前記正極活物質が塗布された部分の全面が前記負極板に対向するように前記正極板と前記負極板を前記セパレータを介して巻回したことを特徴とする請求項１に記載のリチウムイオン電池。

【請求項３】　前記金属外装缶はアルミニウムあるいはアルミニウム合金より形成したことを特徴とする請求項１または請求項２に記載のリチウムイオン電池。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はリチウムイオン電池に係り、特に、正極板と負極板をセパレータを介して巻回して電極体とし、この電極体を電解液とともに金属外装缶に収納して封缶したリチウムイオン電池に関する。

【０００２】

【従来の技術】近年、電子機器の小型化、軽量化はめざましく、それに伴い、電源となる電池に対しても小型軽量化の要望が非常に大きい。一次電池の分野では既にリチウム電池等の小型軽量電池が実用化されているが、これらは一次電池であるが故に繰り返し使用できず、その用途は限られたものであった。一方、二次電池の分野では従来より鉛蓄電池、ニッケル－カドミウム蓄電池、ニッケル－水素蓄電池等が用いられてきたが、これらは小型軽量化という点で大きな問題点を有している。

【０００３】そこで、小型軽量でかつ高容量で充放電可能な電池としてリチウムイオン電池が実用化されるようになり、小型ビデオカメラ、携帯電話、ノートパソコン等の携帯用電子・通信機器等に用いられるようになった。この種のリチウムイオン電池は、負極活物質としてリチウムイオンを吸蔵・脱離し得るカーボン系材料を用い、正極活物質として、$LiCoO_2$，$LiNiO_2$，$LiMn_2O_4$，$LiFeO_2$等のリチウム含有遷移金属酸化物を用い、電解液として有機溶媒に溶質としてリチウム塩を溶解したイオン伝導体を用い、電池として組み立てた後、初回の充電により正極活物質から出たリチウムイオンがカーボン粒子内に入って充放電可能となる電池である。

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【０００４】このリチウムイオン電池は、正極活物質および負極活物質をそれぞれ金属製の芯体（箔）に塗布して正極板および負極板とし、セパレータを間に入れて巻回して電極体とする。この電極体を金属製の外装缶に挿入した後、外装缶内に電解液を充填して封缶することにより組み立てられる。金属製の外装缶としては鉄、ステンレス製外装缶あるいはアルミニウム、アルミニウム合金製等の外装缶が用いられる。

【０００５】ここで、鉄、ステンレス製外装缶を用いる場合は、外装缶を負極にして上記電極体の最外周が負極になるように構成し、アルミニウム、アルミニウム合金製外装缶を用いる場合は、外装缶を正極にして上記電極体の最外周が正極になるように構成している。このように構成することにより、外装缶と電極板との短絡を防止するとともに、外装缶の金属が電解液中に溶出することを防止している。

【０００６】

【発明が解決しようとする課題】ところで、リチウムイオン電池において、正極板の板幅が負極板の板幅より大きい場合、充電の際に、負極板の板幅から突出した正極板の正極活物質から出るリチウムイオンが負極板の両端部に集中して、リチウムデンドライトが析出するようになる。したがって、このリチウムデンドライトの析出を防止するために、正極板の板幅を負極板の板幅より小さく形成するとともに、正極板の全面が負極板に対向するように巻回している。

【０００７】ここで、アルミニウム製外装缶あるいはアルミニウム合金製外装缶を用いる場合、外装缶は正極となるため、正極板の板幅を負極板の板幅より小さく形成したものを用いると、このリチウムイオン電池を落下した等により外装缶に外力が加わって、外装缶の底部に凹み等を生じると、正極端子となる外装缶と負極板が接触して短絡するという問題を生じる。そして、外装缶と負極板とが短絡すると、短絡部が発熱して電池が破損する恐れを生じる。

【０００８】そこで、本発明は上記問題点に鑑みてなされたものであり、正極端子となる外装缶に外力が加わって外装缶が変形しても、この外装缶と負極板とが接触しないように電極体を構成して短絡を防止することにある。

【０００９】

【課題を解決するための手段およびその作用・効果】本発明は、正極板と負極板をセパレータを介して巻回して電極体とし、この電極体を電解液とともに正極端子となる金属外装缶に収納して封缶してなるリチウムイオン電池であって、上記課題を解決するために、請求項１に記載の発明においては、電極体の最外周に正極板を配設するとともに、正極板の板幅を負極板の板幅より大きく形成したことにある。

【００１０】このように、正極板の板幅を負極板の板幅

より大きく形成するとともに、電極体の最外周に正極板を配設すると、正極端子となる外装缶に外力が加わって外装缶が変形しても、この変形した部分は負極板より大きく形成された正極板に接触することとなるので、正極端子となる外装缶と負極板とが接触することが防止でき、短絡を防止できるようになる。

【００１１】請求項２に記載の発明においては、上述の正極板は極板芯体の両端部が露出するように正極活物質を塗布してなり、負極板は極板芯体の全面に負極活物質を塗布してなり、正極活物質の塗布幅は負極活物質の塗布幅より小さくするとともに、正極活物質が塗布された部分の全面が負極板に対向するように正極板と負極板をセパレータを介して巻回したことにある。このように、正極活物質の塗布幅を負極活物質の塗布幅より小さくすると、正極板の板幅を負極板の板幅より大きく形成してもリチウムデンドライトの析出を防止できるようになる。

【００１２】請求項３に記載の発明においては、上述の金属外装缶はアルミニウムあるいはアルミニウム合金より形成したことにある。アルミニウムあるいはアルミニウム合金は、鉄あるいはステンレスより比重が小さいので、この種のリチウムイオン電池の軽量化が可能になる。

【００１３】

【発明の実施の形態】以下に、本発明のリチウムイオン電池の一実施形態を図１および図２に基づいて説明する。なお、図１は正・負極板をセパレータを介して重ね合わせた状態を示す図であり、図２はセパレータを介して重ね合わせた正・負極板を巻回して外装缶内に収納した状態を示す図である。

【００１４】ａ．負極板の作製

天然黒鉛よりなる負極活物質とポリビニリデンフルオライト（ＰＶＤＦ）よりなる結着剤等とを、Ｎ－メチルピロリドンからなる有機溶剤等に溶解したものを混合して、スラリーあるいはペーストとする。これらのスラリーあるいはペーストを、スラリーの場合はダイコーター、ドクターブレード等を用いて、ペーストの場合はローラコーティング法等により金属芯体（例えば、長さが３２０ｍｍ、幅が４０ｍｍ、厚みが２０μｍの銅箔）１１の両面の全面にわたって均一に塗布して、活物質層１２を塗布した負極板１０を形成する。

【００１５】この後、活物質層１２を塗布した負極板１０を乾燥機中を通過させて、スラリーあるいはペースト作製に必要であった有機溶剤を除去して乾燥させる。この後、この乾燥負極板１０をロールプレス機により圧延して、厚みが０．１４ｍｍの負極板１０とする。

【００１６】なお、負極活物質としては、天然黒鉛以外に、リチウムイオンを吸蔵・脱離し得るカーボン系材料、例えば、グラファイト、カーボンブラック、コークス、ガラス状炭素、炭素繊維、またはこれらの焼成体等

が好適である。また、酸化錫、酸化チタン等のリチウムイオンを吸蔵・脱離し得る酸化物を用いてもよい。

【００１７】ｂ．正極板の作製

一方、$LiCoO_2$からなる正極活物質と、アセチレンブラック、グラファイト等の炭素系導電剤と、ポリビニリデンフルオライト（ＰＶＤＦ）よりなる結着剤等とを、Ｎ－メチルピロリドンからなる有機溶剤等に溶解したものを混合して、スラリーあるいはペーストとする。なお、スラリーあるいはペースト中にポリエチレンオキシド、ポリアクリロニトリル、セルロース等の添加剤を添加してもよい。

【００１８】これらのスラリーあるいはペーストを、スラリーの場合はダイコーター、ドクターブレード等を用いて、ペーストの場合はローラコーティング法等により金属芯体（例えば、長さが３４０ｍｍ、幅が４１ｍｍ、厚みが２０μｍのアルミニウム箔）２１の両面の上・下端部にそれぞれ約１ｍｍ幅の不塗布部２３を残して均一に塗布（なお、一部は片面のみに塗布する）して、活物質層２２を塗布した正極板２０を形成する。

【００１９】なお、この正極板２０は、後述する電極体Ａとした場合に最外周になる部分の片面には活物質層２２を塗布しないように塗布している。このように、電極体Ａとした場合に最外周になる部分の正極板２０の片面に活物質層２２を塗布しないと、金属芯体２１と外装缶４０とが直接接触するようになるので接触抵抗を減少させることが可能になるとともに、電池反応に寄与しない無駄な活物質を節約することができるようになる。

【００２０】この後、活物質層２２を塗布した正極板２０を乾燥機中を通過させて、スラリーあるいはペースト作製に必要であった有機溶剤を除去して乾燥させる。乾燥後、この乾燥正極板２０をロールプレス機により圧延して、厚みが０．１７ｍｍの正極板２０とする。このよう形成された正極板２０は、幅方向の上・下端部はそれぞれ１ｍｍ幅の不塗布部２３が形成されることとなるので、この不塗布部２３は金属芯体２１が露出することとなる。

【００２１】なお、正極活物質としては、$LiCoO_2$以外に、リチウムイオンをゲストとして受け入れ得るリチウム含有遷移金属化合物、例えば、$LiNiO_2$、$LiCo_xNi_{(1-x)}O_2$、$LiCrO_2$、$LiVO_2$、$LiMnO_2$、α$LiFeO_2$、$LiTiO_2$、$LiScO_2$、$LiYO_2$、$LiMn_2O_4$等が好ましいが、特に、$LiNiO_2$、$LiCo_xNi_{(1-x)}O_2$を単独で用いるかあるいはこれらの二種以上を混合して用いるのが好適である。また、ポリアセチレン、ポリアニリン等の導電性ポリマーを用いてもよい。

【００２２】ｃ．電極体の作製

上述のようにして作製した負極板１０と正極板２０とを、有機溶媒との反応性が低く、かつ安価なポリオレフィン系樹脂からなる微多孔膜、好適にはポリエチレン製

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微多孔膜（例えば、長さが７２０ｍｍ、幅が４２ｍｍ、厚みが０．０２５ｍｍのものを長さ方向に半分に折り返したもの）３０を間にし、かつ、各極板１０，２０の幅方向の中心線を一致させて重ね合わせる。この後、正極板２０が外側になるようにする（即ち、負極板１０が内側になるようにする）とともに、上記した片面のみに正極活物質が塗布された部分の金属芯体２１が露出した部分が外側になるようにし、かつ、露出した部分が巻き終わり部となるようにして、図示しない巻き取り機により巻回する。この後、最外周をテープ止めして渦巻状電極体とした後、プレス機で角形外装缶に挿入できるような形に成形して電極体Ａとする。

【００２３】ｄ．リチウムイオン電池の作製

ついで、１枚板からプレス加工により成形したアルミニウム合金製の角形外装缶（例えば、外形寸法が、高さ４６ｍｍ、幅２２ｍｍ、厚み７．５ｍｍ、肉厚０．５ｍｍのもの）４０の内底部と、上述のようにして作製した電極体Ａの正極板２０の一部に溶接した図示しない正極リードとを溶接した後、この電極体Ａを外装缶４０内に挿入する。この後、電極体Ａの上部にスペーサ４１を挿入し、負極板１０の一部に溶接した負極リード４２と負極端子４３とを溶接する。

【００２４】この後、外装缶４０の開口部に封口板４４を載置して封口し、エチレンカーボネート（ＥＣ）３０重量部とジエチルカーボネート（ＤＥＣ）７０重量部よりなる混合溶媒に電解質塩として１ＭＬｉＰＦ$_6$を添加した電解液を注入する。ついで、負極端子を兼ねる封口キャップ４５と負極端子４３とを溶接した後、充電して本実施形態のリチウムイオン電池とする。なお、電解液としては、有機溶媒に溶質としてリチウム塩を溶解したイオン伝導体であって、イオン伝導率が高く、正・負の各電極に対して化学的、電気化学的に安定で、使用可能温度範囲が広くかつ安全性が高く、安価なものを使用する。

【００２５】例えば、有機溶媒としては上記エチレンカーボネート（ＥＣ）とジエチルカーボネート（ＤＥＣ）との混合溶媒以外に、プロピレンカーボネート（ＰＣ）、スルフォラン（ＳＬ）、テトラハイドロフラン（ＴＨＦ）、γブチロラクトン（ＧＢＬ）、ジメチルカーボネート（ＤＭＣ）、エチルメチルカーボネート（ＥＭＣ）、１，２ジメトキシエタン（ＤＭＥ）等あるいはこれらの混合溶媒が好適である。また、溶質としては電子吸引性の強いリチウム塩を使用し、上記ＬｉＰＦ$_6$以外に例えば、ＬｉＢＦ$_4$、ＬｉＣｌＯ$_4$、ＬｉＡｓＦ$_6$、ＬｉＣＦ$_3$ＳＯ$_3$、Ｌｉ（ＣＦ$_3$ＳＯ$_2$）$_2$Ｎ、ＬｉＣ$_4$Ｆ$_9$ＳＯ$_3$等が好適である。

【００２６】（比較例）以下に、比較例のリチウムイオン電池を図３および図４に基づいて説明する。なお、図３は正・負極板をセパレータを介して重ね合わせた状態を示す図であり、図４はセパレータを介して重ね合わせた正・負極板を巻回して外装缶内に収納した状態を示す図である。

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【００２７】ｅ．比較例の負極板の作製

天然黒鉛よりなる負極活物質とポリビニリデンフルオライト（ＰＶＤＦ）よりなる結着剤等とを、Ｎ－メチルピロリドンからなる有機溶剤等に溶解したものを混合して、スラリーあるいはペーストとする。これらのスラリーあるいはペーストを、スラリーの場合はダイコーター、ドクターブレード等を用いて、ペーストの場合はローラコーティング法等により金属芯体（例えば、長さが３２０ｍｍ、幅が４０ｍｍ、厚みが２０μｍの銅箔）５１の両面の全面にわたって均一に塗布して、活物質層５２を塗布した負極板５０を形成する。

【００２８】この後、活物質層５２を塗布した負極板５０を乾燥機中を通過させて、スラリーあるいはペースト作製に必要であった有機溶剤を除去して乾燥させる。この後、この乾燥負極板５０をロールプレス機により圧延して、厚みが０．１４ｍｍの比較例の負極板５０とする。

【００２９】ｆ．比較例の正極板の作製

一方、ＬｉＣｏＯ$_2$からなる正極活物質と、アセチレンブラック、グラファイト等の炭素系導電剤と、ポリビニリデンフルオライト（ＰＶＤＦ）よりなる結着剤と、ポリビニリデンフルオライト（ＰＶＤＦ）よりなる結着剤等とを、Ｎ－メチルピロリドンからなる有機溶剤等に溶解したものを混合して、スラリーあるいはペーストとする。なお、スラリーあるいはペースト中にポリエチレンオキシド、ポリアクリロニトリル、セルロース等の添加剤を添加してもよい。

【００３０】これらのスラリーあるいはペーストを、スラリーの場合はダイコーター、ドクターブレード等を用いて、ペーストの場合はローラコーティング法等により金属芯体（例えば、長さが３４０ｍｍ、幅が３９ｍｍ、厚みが２０μｍのアルミニウム箔）６１の両面の全面に均一に塗布して、活物質層６２を塗布した正極板６０を形成する。なお、この正極板６０は、後述する電極体Ｂとした場合に最外周になる部分の片面には活物質層６２を塗布しないように塗布している。

【００３１】この後、活物質層６２を塗布した正極板６０を乾燥機中を通過させて、スラリーあるいはペースト作製に必要であった有機溶剤を除去して乾燥させる。乾燥後、この乾燥正極板６０をロールプレス機により圧延して、厚みが０．１７ｍｍの比較例の正極板６０とする。

【００３２】ｇ．比較例の電極体の作製

上述のようにして作製した比較例の負極板５０と正極板６０とを、有機溶媒との反応性が低く、かつ安価なポリオレフィン系樹脂からなる微多孔膜、好適にはポリエチレン製微多孔膜（例えば、長さが７２０ｍｍ、幅が４１ｍｍ、厚みが０．０２５ｍｍのものを長さ方向に半分に

折り返したもの）７０を間にし、かつ、各極板５０，６０の幅方向の中心線を一致させて重ね合わせる。この後、正極板６０が外側になるようにするとともに、上記した片面のみに正極活物質が塗布された部分の金属芯体６１が露出した部分が外側になるようにし、かつ、露出した部分が巻き終わり部となるようにして、図示しない巻き取り機により巻回する。この後、最外周をテープ止めして渦巻状電極体とした後、プレス機で角形に成形して電極体Ｂとする。

【００３３】ｈ．比較例のリチウムイオン電池の作製

ついで、１枚板からプレス加工により成形したアルミニウム合金製の角形外装缶（例えば、外形寸法が、高さ４６ｍｍ、幅２２ｍｍ、厚み７．５ｍｍ、肉厚０．５ｍｍのもの）８０の内底部と、上述のようにして作製した電極体Ｂの正極板６０の一部に溶接した図示しない正極リードとを溶接した後、この電極体Ｂを外装缶８０内に挿入する。この後、電極体Ｂの上部にスペーサ８１を挿入し、負極板５０の一部に溶接した負極リード８２と負極端子８３とを溶接する。

【００３４】この後、外装缶８０の開口部に封口板８４を載置して封口し、エチレンカーボネート（ＥＣ）３０重量部とジエチルカーボネート（ＤＥＣ）７０重量部よりなる混合溶媒に電解質塩として１ＭＬｉＰＦ$_6$を添加した電解液を注入する。ついで、負極端子を兼ねる封口キャップ８５と負極端子８３とを溶接した後、充電して比較例のリチウムイオン電池とする。

【００３５】落下実験

上述のように作製した本実施形態のリチウムイオン電池１００個と、上述のように作製した比較例のリチウムイオン電池１００個を用意する。これらの１００個のリチウムイオン電池を、それぞれ床上１．９ｍの高さからコンクリート製の床上にランダムの方向に落下させる落下実験（ＵＬ規格）をそれぞれ５００回ずつ行った。この実験結果を示すと、以下の表１のような結果となった。

【００３６】

【表１】

	短絡した電池の個数
本発明の電池	０個
比較例の電池	５個

【００３７】上記表１より明らかなように、本発明のリチウムイオン電池で短絡が発生したものはなかった。このように優れた特性となる理由は、正極板２０の板幅（例えば、４１ｍｍ）を負極板１０の板幅（例えば、４０ｍｍ）より大きく形成すると正極端子となる外装缶４０に外力が加わって外装缶４０が変形しても、この変形した部分は負極板１０より大きく形成された正極板２０に接触することとなるので、正極端子となる外装缶４０と負極板１０とが接触することが防止でき、短絡を防止できるようになるからである。

【００３８】また、正極板２０の板幅（例えば、４１ｍｍ）を負極板１０の板幅（例えば、４０ｍｍ）より大きく形成しても、正極活物質の塗布幅を負極活物質の塗布幅より小さくすると、リチウムデンドライトの析出を防止できるようになる。

【００３９】さらに、アルミニウムあるいはアルミニウム合金は、鉄あるいはステンレスより比重が小さいので、金属製外装缶の材質をアルミニウムあるいはアルミニウム合金とすると、この種のリチウムイオン電池の軽量化が可能になる。

【図面の簡単な説明】

【図１】　本発明の一実施形態の正・負極板をセパレータを介して重ね合わせた状態を示す図である。

【図２】　本発明の一実施形態のセパレータを介して重ね合わせた背・負極板を巻回して外装缶内に収納した状態を示す図である。

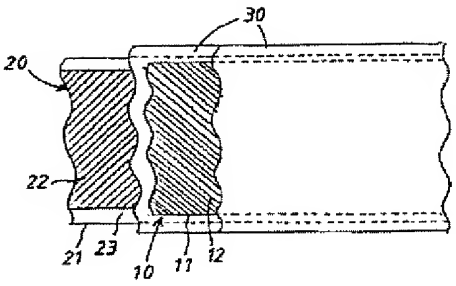
【図３】　比較例の正・負極板をセパレータを介して重ね合わせた状態を示す図である。

【図４】　比較例のセパレータを介して重ね合わせた背・負極板を巻回して外装缶内に収納した状態を示す図である。

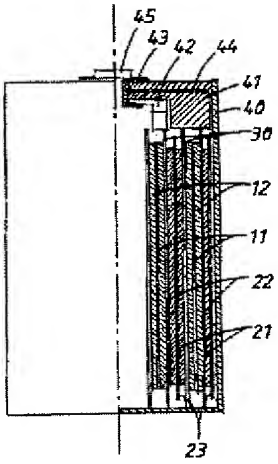
【符号の説明】

１０…負極板、１１…金属芯体、１２…負極活物質層、２０…正極板、２１…金属芯体、２２…正極活物質層、２３…不塗布部、３０…セパレータ、４０…金属外装缶（正極端子）、４５…封口キャップ（負極端子）

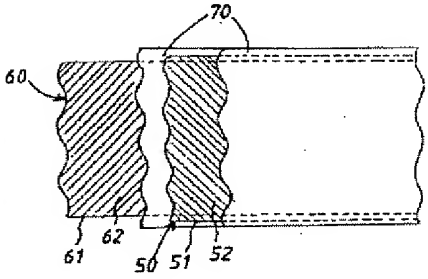
【図１】


30
20
22
21
23
10
11
12

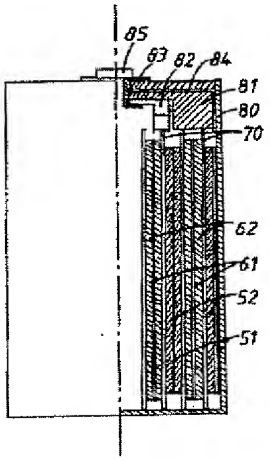
【図２】


45
43
42
44
41
40
30
12
11
22
21
23

【図３】


70
60
61
62
50
51
52

【図４】


85
83
82
84
81
80
70
62
61
52
51